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THESIS FOR THE DEGREE OF
MASTER OF SCIENCE IN FOOD AND NUTRITION

Dietary and health-related characteristics of Korean adolescent night eaters

한국 청소년의 야식 섭취에 따른 식생활 및 건강 관련 특성

August 2015

Department of Food and Nutrition
Graduate School
Seoul National University

Emely Yessenia Hernandez Mateo

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서울대학교
식품영양학과
에멜리 제쎄냐 헤르난데즈 마테오
(Emely Yessenia Hernandez Mateo)

에멜리 제쎄냐 헤르난데즈 마테오의
석사학위논문을 인준함

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위 원 장_____(인)
부위원장_____(인)
위　　원_____(인)

Abstract

Dietary and health-related characteristics of Korean adolescent night eaters

Emely Hernandez
Department of Food and Nutrition
Graduate School
Seoul National University

A growing body of research indicates that delayed eating behaviours like night eating could be associated with poor diet quality, risky health behaviours and a greater risk of obesity. This study aimed to examine dietary and health-related characteristics of Korean adolescent night eaters. The present study analysed the data from one day 24-h dietary recall and a demographic survey of 1,738 Korean adolescents aged 12 to 18 years old, abstracted from the 2010-2012 Korea National Health and Nutrition Examination Survey (KNHANES). In this study, 'night eating' was defined as consuming 25% or more out of the daily Total Energy Intake between 21:00 and 06:00, and the subjects who did this were classified as

'night eaters', while the rest were considered 'non-night eaters'. Around 21% of Korean adolescents appeared to be night eaters. The results of Rao Scott Chi-square tests and t-tests indicated that adolescent night eaters showed increased breakfast skipping ($p=0.001$) and lower diet quality as evidenced by lower Dietary Diversity Scores ($p=0.008$), higher intake of energy from snacks ($p<0.001$) and greater proportion of energy from fat ($p=0.029$) when compared to non-night eaters. There were no significant differences between night eaters and non-night eaters in daily food group intake. The results from logistic regression analysis indicated that adolescents whose both parents were night eaters were 4.37 times as likely to be night eaters as those whose parents weren't and male adolescents presented 1.85 times higher odds of night eating than females. Only female adolescents showed a significant relationship between night eating and BMI z-scores ($\beta=0.28$, $p=0.004$) in multiple linear regression analyses. According to the results of multinomial logistic

regression, however, night eating did not increase the odds of being overweight or obese. Therefore, the relationship between night eating and BMI z-score was limited to female adolescents who were within healthy weight status. In summary, male adolescents as well as those whose parents were night eaters showed higher tendency to be night eaters. Also, night eating among Korean adolescents was related to delayed eating behaviours, such as breakfast skipping and lower daytime energy intake, and lower diet quality in general. These results suggest that night eating should be considered when designing nutrition education programs targeting adolescents.

Keywords: Night eating, adolescent night eaters, chrononutrition, KNHANES.

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I. INTRODUCTION

1. Study Background

Adolescence is characterized by critical changes in several aspects of life. Among these, a rapid growth spurt, both in height and weight, is one of the most evident physical transformations. These changes, along with other modifiable factors, place adolescents at a higher risk category for poor dietary choices and weight-related health problems (Laurson, Lee, and Eisenmann 2014).

Worldwide, the prevalence of obesity and overweight has increased among children and adolescents, becoming epidemic in both developing and developed nations (Popkin and Gordon-Larsen 2004, Wang and Lobstein 2006). South Korea hasn't been exempted from this global trend. From 2008 to 2012, overall prevalence of obesity in children and adolescents increased from 11.2% to 14.7% (Statistics Korea, 2013). Some of the elements that seem to be associated with a higher likelihood of obesity amongst South Korean adolescents were low socio-economic status,

dieting patterns and sitting more than 2 hours a day (Kim et al. 2013).

Diet is an important modifiable factor that influences health and weight status. Research has shown associations between changes in Korean adolescent's diet overtime and an increased risk of being overweight (Song et al. 2009). Recently, temporal distribution of food consumption research has emerged as a possible culprit in the association between diet and health indicators. The combination of timing of food intake and specific nutrient profiles has been associated with metabolic abnormalities (Almoosawi et al. 2013b). For instance, breakfast skipping has been related to obesity in the general population (Deshmukh-Taskar et al. 2013, Huang et al. 2010) and evidence has suggested that breakfast skipping could be linked to increased weight gain during the transition from adolescence to adulthood (Niemeier et al. 2006).

In particular, food intake during night-time has been associated with lower dietary quality in children (Gallant,

Lundgren, and Drapeau 2014), adolescents (Cho et al. 2014) and adults (Baron et al. 2011), and also with higher Body Mass Index (BMI) and a greater likelihood of being obese (Huang 2014, Lamerz et al. 2005, Wang et al. 2014). In both South Korea and the United States, night eating has shown a greater prevalence among young adults (Jung et al. 2006, Striegel-Moore et al. 2006, Suh, Lee, and Chung 2012)

Most South Korean studies about the subject have focused on young adults (Hong, Yeon, and Bae 2013, Joung and Koo 2014, Jun, Choi, and Yun-Jung 2015). To our knowledge, only one study to date has analysed the phenomenon in adolescents in South Korea. The study investigated night eating habits in middle school students living in Gyeonggi province, concluding that night intake mainly consisted of carbohydrate and fat rich foods (Cho et al. 2014). Nevertheless, until now no other studies have extensively studied night eating among Korean adolescents.

2. Purpose of the study

The purpose of the current study was to examine dietary and health-related characteristics, and general factors associated with night eating. The specific objectives of the present study are the following:

- Measure the occurrence of night eating among Korean adolescents.
- Compare dietary and health-related characteristics between night eaters and non-night eaters among Korean adolescents.
- Identify the factors related to night eating among Korean adolescents.
- Evaluate dietary intake and dietary quality of night eaters and non-night eaters among Korean adolescents.
- Determine if there is a relationship between night eating and body weight among Korean adolescents.

3. Definition of terms

Table 1. Definition of terms

Term	Definition
Adolescence	The World Health Organization defines adolescence as the period in human growth and development that occurs after childhood and before adulthood, from ages 10 to 19 (World Health Organization 2014). For the purposes of this study adolescence is the period of human development between 12 and 18 years old.
Night-time, night hours	These two terms were used indistinctively to refer to the time period between 21:00 and 06:00; the precise delimitation of night-time hours was operationalized as two periods in this study: from 01:00 hrs to 06:00 hrs and from 21:00 hrs to 00:59 hrs of the same calendar day due to the nature of the data utilized.
Night eating	Consumption of 25% or more out of the daily Total Energy Intake (TEI) between 21:00 and 06:00.
Night eater	Person who has an intake of 25% or more out of the daily TEI between 21:00 and 06:00.
Non-night eater	Person who has an intake of less than 25% of the daily TEI between 21:00 and 06:00, including individuals who had no energy intake during night-time.

II. LITERATURE REVIEW

1. Definition of night eating

Modern life has brought a complete shift in how humans live and behave. In particular it has affected our relationship with food, not only in terms of what we eat, but also when we eat it. The emerging field of chrononutrition, takes in account the temporal aspect of food intake and how circadian systems affect dietary and metabolic processes (Garaulet, Ordovas, and Madrid 2010). Fast and busy lifestyles coupled with exposure to artificial lights facilitate eating during night hours (Wyse, Biello, and Gill 2014), something that a few hundreds of years ago was not a part of human activity. Subjects with an enhanced predilection for evening hours in daily activities have shown to practice adverse health behaviours, such as unfavourable dietary habits, when compared to individuals who prefer evening hours (Kanerva et al. 2012).

The study of nocturnal food intake seems to be a complicated subject, due to the lack of uniform definitions

of both ‘night eating’ and the related eating disorder denominated ‘Night Eating Syndrome’ (NES) (de Zwaan et al. 2006). While night eating has been defined as evening hyperphagia, definitions across different studies show diverse criteria to describe it. In a basic sense, evening hyperphagia is understood as an excessive food intake during night hours. Most studies agree that evening hyperphagia refers to the intake of at least 25% of total daily calories at night, but some have defined the amount of energy intake as high as 50% of more of daily caloric intake (Stunkard et al. 1996).

Also, while some studies include the last meal of the day as part of the nocturnal caloric intake (Stunkard et al. 1996), others specify that the calorie counting starts after the last evening meal (Birketvedt et al. 1999, Gluck, Geliebter, and Satov 2001). This may add an element of ambiguity to the definition, since it requires a subjective assessment on part of the respondent to determine whether a determined eating occasion can be considered a meal or a snack. Other

definitions set a specific time frame to define night-time, but this shows variations across different populations due to age, cultural and socioeconomic differences (Lamerz et al. 2005, Rand, Macgregor, and Stunkard 1997).

On the other hand, NES has been classically defined as a behavioural eating disorder that, besides evening hyperphagia, also includes morning anorexia and sleep disturbances (de Zwaan et al. 2006). The diagnostic criteria for NES has experienced several variations over time, like the inclusion of awakenings from sleep and consumption of snacks during these awakenings (Birketvedt et al. 1999). The inconsistency of definitions and criteria are an impediment for a uniform interpretation of research results on the topic.

A Study by Striegel-Moore intended to find out the prevalence of night eating in adolescent girls using five different definition criteria for night eating that varied in percentage of daily caloric intake during night, type of meals included and time frame used to define night. This

study reported that the frequency of night eating varied depending on the definition used to describe the behaviour with the least restrictive definitions showing the highest prevalence while definitions with more restrictive criteria showed lower prevalence (Striegel-Moore et al. 2004).

2. Dietary characteristics related to night eating

Food intake during night-time has been associated with lower dietary quality across different age groups. Research in a prospective cohort study investigating obesity risk factors in the youth showed that children with higher Night Eating Questionnaire (NEQ) scores had a higher percentage of fat intake, greater sodium intake, fewer servings of fruits and vegetables and a higher intake of unhealthy snacks (Gallant, Lundgren, and Drapeau 2014).

Another study investigated night eating habits in middle school students living in Gyeonggi province, South Korea, concluding that night food intake predominantly consisted of carbohydrate and fat rich foods (Cho et al. 2014). The

diet quality of adults could also be affected by night eating behaviour as evidenced by an observational comparison of normal and late sleepers, which reported that adult late-sleepers who also consumed more calories at dinner and after 20:00 (35 % of Total Energy Intake), had higher fast food, full-calorie soda and lower fruit and vegetable consumption.

In Korea, the study of night eating has increased in recent years. This phenomenon has shown a higher occurrence among young adults. (Jung et al. 2006). A study comparing nutritional status by energy level of night snack consumption in Korean adults found out night eaters tended to be male adults and younger individuals with higher education levels, higher income, breakfast skipping and frequent eating out (Suh, Lee, and Chung 2012). Until this date, only one study has focused in night eating among Korean adolescents. This study showed that among middle school students in Gyeonggi province 60% had night eating more than once a week, most night eating was done

between 22:00 and 23:00 and that subjects who belonged to the night eating group had higher scores for picky eating, overeating and salty eating (Cho et al. 2014).

3. Health characteristics related to night eating

In children, night eating has been associated with existing maternal eating disturbances and being born from immigrant mothers (Lamerz et al. 2005). Specifically, children of mothers who reported night eating had more than seven times the risk of also suffering from night eating than children from mothers who did not (Lamerz et al. 2005).

Sleep appears to be one of the main factors related to NES, to the point that whether NES is a sleeping disorder or an eating disorder it's up for debate (Winkelman 2006). A study about the effect of sleep restriction in diet and weight gain showed that the caloric intake sleep of restricted individuals was greater during days when bedtime was delayed until 04:00 compared to baseline

conditions and recovery days (Spaeth, Dinges, and Goel 2013).

Other possible factors to take in account are the existence of psychological accompanying symptoms that could be part of entities that do not conform to all the necessary criteria to be classified as NES but share common features (de Zwaan et al. 2014). Factors like stress, depression, and intention to lose weight could be part of non-syndromic eating disorders. Dieting can be related to other eating disorders but persons with NES don't seem to be as severely affected by body dysmorphia and desire to lose weight as those with other related eating disorders, such as Binge Eating Disorder (de Zwaan et al. 2006, Stunkard and Costello Allison 2003). Korean studies indicate that and night eating seems to be related to current smoking, moderate to heavy alcohol drinking and mild depressive trait (Jung et al. 2006).

Higher levels of energy intake during night have been reported to be associated with higher BMI. A study

evaluating the timing of sleep and feeding on weight regulation in humans reported that calories consumed after 20:00 predicted BMI, and stated that this may be an indicator that night energy intake could increase the risk of obesity (Baron et al. 2011). Another research looked at the associations of energy intake in the morning, midday and evening with body weight, showing that higher energy intake in the evening increased the likelihood of being overweight/obese (Wang et al. 2014).

On the other hand, NES was initially described in obese patients (Stunkard, Grace, and Wolff 1955), but later research has reported that the presence of the syndrome was not related to obesity (Rand, Macgregor, and Stunkard 1997). A study performed in a similar number of obese and non-obese subjects who were identified as suffering from NES, showed that these two groups had very few differences when responding the Night Eating Questionnaire (NEQ), except for the fact that non-obese subjects were considerably younger than the obese group

(Marshall et al. 2004). This suggests that NES could contribute to the development of obesity later in life.

Night eating symptoms have also been associated with weight gain (Gallant et al. 2015) and less weight loss in already obese patients (Gluck, Geliebter, and Satov 2001). There is a paucity of studies that evaluate night eating influence in body weight of adolescents. An unpublished study performed in Hong Kong adolescents indicated that BMI z-score was positively associated with night eating and that night eaters were 13% more likely to be obese than those who didn't eat at night (Huang 2014). To our knowledge there are no similar studies in South Korea.

III. METHODS

1. Data source

The data used in this study were obtained from the 2010-2012 Korea National Health and Nutrition Examination Survey (KNHANES V), conducted by the Korea Center for Disease Control and Prevention (KCDC). A final sample of 1,738 subjects was selected from an initial number of 2,193 eligible subjects aged 12-18 years old (Figure 1).

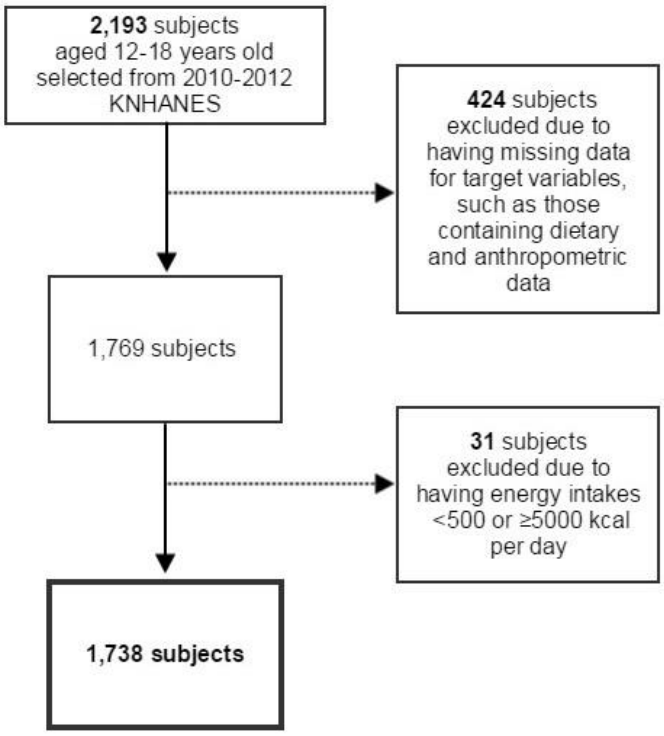

Figure 1. Flowchart for subject selection

Initially, 424 subjects were excluded for showing missing values for target variables and 31 subjects were excluded for reporting implausible energy intakes (<500 or ≥5000 kcal per day).

For the analysis of factors related to night eating, a subsample of 1,204 subjects was obtained after excluding 534 subjects who had missing key variables and those who did not have dietary data for both parents. Also, the analysis of the relationship of BMI z-scores and night eating used a sample of 1,698 subjects after excluding 44 subjects with missing values.

2. Data analysis

2.1 General characteristics

This study examined as general characteristics: age, sex, household income, parental education level, parental night eating habits, adolescent stress levels, sleep hours, breakfast skipping, recent dieting and physical activity level.

Breakfast skipping was operationalized as two consecutive days in which a subject did not have any breakfast intake. The KNHANES has two items that address breakfast skipping, the first refers to breakfast skipping on the day of the interview and the second to the day before. If a subject did not consume breakfast on both days, it was considered breakfast skipping.

Level of physical activity was classified according to the frequency and time that subjects performed moderate and/or vigorous physical activity. Subjects who did not perform any physical activity were classified as 'inactive'; while those who carried out moderate physical activity for at least 30 minutes a day for five days or more, and/or vigorous physical activity for at least 20 minutes for 3 or more days a week were classified as 'active'. The rest of the subjects were considered 'inadequately active'.

Some of the variables used to describe general characteristics of the sample that have been associated with night eating in previous studies, were further used to

determine factors associated with night eating.

2.2 Dietary characteristics

In this study, 'night eating' was defined as consuming 25% or more out of the daily Total Energy Intake (TEI) between 21:00 and 06:00 (de Zwaan et al. 2014). The subjects complying with the preceding condition were considered 'night eaters'. On the other hand, those who consumed less than 25% from daily TEI between 21:00 hrs and 06:00 hrs, including subjects who had zero caloric intake, were considered to be 'non-night eaters'. Since the data were obtained from only a one day 24h recall, the precise delimitation of night-time hours was operationalized as two periods in this study: from 00:00 to 06:00 and from 21:00 to 23:59 of the same calendar day. The dataset was checked for coding inconsistencies for the time variable. Furthermore, the distribution of night eating energy intake was operationalized as interval groups increasing by 25%, in order to find out about the

distribution of energy intake at night.

The dietary data used in this study were collected by a 24 hour recall. Food groups were obtained from the Korean Nutrition Intake Standards and a serving was determined according to the amount of calories consumed from each group as follows: 1) grains (300 kcal), 2) meat, eggs, fish, and beans (80 kcal), 3) vegetables (15 kcal), 4) fruits (50 kcal), 5) milk and dairy products (125 kcal) and 6) oils and sugars (45 kcal) (Korean Nutrition Society [KNS] 2010a). Daily nutrient intake was compared between night eaters and non-night eaters. Energy intake was classified taking in account whether it was obtained from a meal or a snack and also whether this meal or snack was consumed at night or during daytime. The percentages of energy obtained during the day from carbohydrates, protein and fat, were calculated for each subject. Dietary intake was classified into six food groups, obtained from the Korean Food Guidance System of Dietary References Intakes for Koreans by the Korean Nutrition Society (KNS 2010a).

In order to evaluate the quality of overall diet, some measures of diet quality were calculated in this study: Nutrient Adequacy Ratio (NAR), Mean Adequacy Ratio (MAR) and Dietary Diversity Score (DDS). MAR was obtained by calculating the mean value of the NAR (World Health Organization [WHO] 1985) of 9 nutrients (protein, vitamin A, vitamin B1, vitamin B2, niacin, vitamin C, calcium, phosphorus and iron) having a Recommended Nutrient Intake (RNI) value according to the Dietary Reference Intakes for Koreans (KDRIs) (KNS 2010b). The NAR for a given nutrient is the ratio of a subject's intake to the current recommended allowance for each sex and age category:

$$NAR = \frac{Actual\ nutrient\ intake\ (per\ day)}{Recommended\ Nutrient\ Intake}$$

The MAR was obtained using the formula by Madden et al. (Madden, Goodman, and Guthrie 1976) and NAR was truncated at 1 in order to avoid that a nutrient with a high NAR would compensate for those with a low NAR.

$$NAR = \frac{\sum NAR\ (each\ truncated\ at\ 1)}{Number\ of\ nutrients}$$

Dietary Diversity Score (DDS) (Kant 1991) was used to measure dietary diversity. DDS is calculated by first classifying individual food intakes into food groups, after excluding foods consumed in amounts less than a certain minimum. DDS includes 5 food groups, and each one provides 1 point towards the total DDS (Kant, Schatzkin, and Ziegler 1995).

DDS included the following groups: grains (including starches and excluding cakes, pies, cookies and pastries), meat (including meat, fish, eggs and beans), fruits (excluding fruit drinks that are not juices), meat, and milk and dairy. For the calculation of DDS 1 point was counted for each food group consumed, excluding foods consumed in less than a minimum amount set for each group. For meat, fruit and vegetable groups, the minimum reported amount for inclusion in the diversity score was 30g for all solid food with a single ingredient and 60g for all liquids and mixed dishes. For the dairy and grain groups the minimum amount of food included was 15g for all solids and

30g for all liquids and mixed dishes. DDS values ranged from 0 to 5 (Kant 1991).

2.3 Health-related characteristics

Some variables explained in general characteristics were analysed in order to explain which factors may be associated with night eating. These variables were sex, parental night eating, stress levels, sleep hours, physical activity level and attempt at weight loss during the past year. These variables have been explained in the general characteristics section

The relation between night eating and body weight was also analysed, using BMI as a measure of body weight. Body mass index (BMI) was obtained by dividing the weight by the square of the height (kg/m^2). BMI was analysed as a measure of weight status using two different variables: BMI z-scores and BMI groups.

In children and adolescents, the interpretation of BMI values requires adjustment for age and sex, because body

fatness varies between sexes and changes as children grow (Centers for Disease Control & Prevention [CDC] 2011). BMI z-scores are a standardized version of BMI. A z-score is a reflection of the number of standard deviations a child or adolescent's BMI is from the mean BMI of the reference population.

BMI z-scores were calculated by using LMS (lambda-mu-sigma) parameters for Korean populations using values from the 2007 Korean National Growth Charts (Korea Centers for Disease Control & Prevention [KCDC] 2007). These growth charts provide sex-age specific LMS parameters to calculate the z-score corresponding to each individual's measured value. The formula used on this calculations was described by the World Health Organization (Preedy 2012):

$$z = \frac{(\frac{y}{M})^L - 1}{SL} \; when \; L \neq 0; \quad z = \frac{ln \; (\frac{y}{M})}{SL} \; when \; L = 0$$

Where y is the BMI value for each subject. A positive z-score indicates a higher-than-average BMI compared to other children of the same age and sex, and a negative z-

score indicates a lower-than-average BMI. Healthy weight was defined as BMI z-score between -2 and 1 Standard Deviations (SD), while thinness was defined as BMI z-score below 2 SD from the median value. Overweight and obesity were defined as BMI z-score over 1 SD and 2 SD above the median value, respectively (World Health Organization [WHO] 2008).

BMI groups were the second measure used to analyse weight status. Adolescents were considered obese if their BMI was at or above the 95th percentile for their age and gender, and they were classified as overweight if their BMI was between the 85th and 95th percentile. Subjects below the 5th percentiles of BMI were classified as underweight; while those between the 5th and 84th percentile of BMI were classified as healthy weight. Percentiles were obtained according to the cut-offs presented in the Korean National Growth Charts (KCDC 2007).

2.4 Statistical analysis

All statistical analyses were performed using IBM SPSS (PASW Statistics 20; SPSS Inc., Chicago IL, USA). The Complex Samples module was used for the analyses performed. This module incorporates adequate sample weights and takes in account the stratification and clustering used in the KNHANES design. Continuous variables were presented as Mean ± standard errors (SE) and categorical variables are given as percentages from total.

The Rao-Scott adjusted χ^2 test was used to examine associations between categorical variables. General characteristics were analysed using t-tests and only including subjects without missing variables for each analysis. ANCOVA, adjusted for age and sex, was used to test for differences on daily nutrient intake and energy nutrient intake per time of the day and per type of eating occasion (meal or snack). These analyses were accomplished using generalized linear models fit to

complex sample survey data using the design-adjusted Wald F statistic.

Binomial logistic regression was used to assess the factors that could be related to night eating. Adjusted Wald F test was used to test association between cross-classified categorical variables. Subjects who did not have dietary data for both parents and those who had missing values for the variables included in the model were excluded. The regression model was later stratified by sex with the same variables except for sex.

Multiple linear regression was performed to assess the relationship between BMI z-score and night energy intake status, after excluding subjects with missing variables. These models were controlled for age, sex and total energy intake; as well as for other factors that can be related to night eating like sedentary lifestyle, stress and lower average sleeping time. The latter variables were dichotomized into two categories. The model was stratified into two models for each sex, in order to find out sex

differences on the relationship between BMI z-score and night eating.

A multinomial logistic regression analysis was conducted to evaluate the relationship between BMI groups and night eating. Wald F statistics tested associations between cross-classified categorical variables in the regression. This model was controlled for confounding variables like age, sex, and total energy intake. This was done to have a more simplified model with a minimum of variables that could be related to night eating or BMI group.

IV. RESULTS

1. Current status of night eating among Korean adolescents

Table 2 showed that about 21% of Korean adolescents consumed 25% or more of their total energy during night-time, and therefore, were classified as night eaters for the purposes of this study.

Night eating in Korean adolescents appeared to be more frequent among high school-aged individuals, despite not being significant at $\alpha=0.05$, when compared to middle school-aged adolescents. High school-aged subjects had a mean percentage of night energy intake of 13.5%, which was significantly higher when compared to middle school-aged subjects.

Table 2. Night eating by age group among Korean Adolescents

Variables	All (n=1,738)	Middle school-aged adolescents (n=925)	High school-aged adolescents (n=813)	p[1]
		Mean ± SE		
Percentage of night energy intake out of TEI[2], %	12.6 ± 0.5	11.1 ± 0.6	13.5 ± 0.7	0.010
Night eating status*		n[3] (%)[4]		
Night eaters	329 (20.8)	162 (18.1)	167 (22.3)	0.057
Non-night eaters	1,409 (79.2)	763 (81.9)	646 (77.7)	

† Age groups were based on those used in the Korean Dietary Reference Intake standards. Middle school aged adolescents: 12-14 years old, High school aged adolescents: 15-18 years old.

*Night eating status: indicates whether energy intake between 21:00 and 06:00 exceeded 25% of Total Energy Intake or not; Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake.

1) p values by Rao-Scott Chi square test or t-test
2) TEI: Total Energy Intake
3) n represents unweighted counts.
4) Percentage of subjects was calculated from weighted frequency.

Table 3 showed the distribution of night energy intake percentages from Total Energy Intake by sex and age group. A 40% of non-night eaters did not have any energy intake during night hours. On the other hand, around 39% of subjects ate at night but, had a night energy intake below 25% of TEI, therefore could not be classified as night eaters for the purposes of this study.

From this table it can also be deduced that around 60% of Korean adolescents ate something at night and they had a night energy intake greater than zero during night hours.

Males were found to have less non-night eaters who had zero intake at night and a higher proportion of males showed intakes between 25-50% of TEI at night. Therefore, males consumed a significantly higher proportion of energy during night hours when compared to females. On the other hand, no differences were found between age groups.

Table 3. Energy intake from night eating as percentages out of Total Energy Intake among Korean adolescents, by sex and age group

Percentage of energy intake at night out of Total Energy Intake	All (n=1,738)	Sex n[1] (%)[2] Male (n=931)	Female (n=807)	P[3]	Age group n[1] (%)[2] Middle school-aged adolescents† (n=925)	High school-aged adolescents† (n=813)	P[3]
0%	705 (40.1)	341 (36.6)	364 (44.3)		398 (43.8)	307 (37.6)	
>0% and <25%	704 (39.3)	380 (39.6)	324 (39.0)		365 (38.1)	339 (40.1)	
≥25% and <50%	266 (16.2)	172 (18.9)	94 (13.1)	0.042	132 (14.6)	134 (17.4)	0.175
≥50% and <75%	55 (3.7)	31 (4.1)	24 (3.3)		28 (3.2)	27 (4.2)	
≥75%	8 (0.6)	7 (0.8)	1 (0.3)		2 (0.3)	6 (0.08)	

† Age groups were based on those used in the Korean Dietary Reference Intake standards. Middle school aged adolescents: 12-14 years old, High school aged adolescents: 15-18 years old.

1) n represents unweighted counts.
2) Percentage of subjects was calculated from weighted frequency.
3) p values by Rao-Scott Chi square test

2. Dietary and health-related characteristics of night eaters and non-night eaters among Korean adolescents

2.1 Characteristics of night eaters and non-night eaters

Table 4 represented general socioeconomic status, dietary and health characteristics of the study subjects, after being classified as night eaters or non-night eaters. The subjects showed significant differences between night eaters and non-night eaters in age, sex and parental night eating.

Night eaters exhibited a tendency to be slightly older (15.3 vs. 15.0 years old). Two thirds of adolescent night eaters were males ($p=0.002$). Also, the prevalence of night eating was higher amongst adolescents whose father or mother were also night eaters ($p=0.001$ and $p<0.001$, respectively). Night eaters also showed increased occurrence of breakfast skipping ($p=0.001$).

Table 4. Characteristics of night eaters and non-night eaters among Korean adolescents

Characteristics	Night eaters*	Non-night eaters*	p[1)]
Age (years), mean ±SE (n=1,738)	15.3 ± 0.12	15.0 ± 0.06	
Sex, % (n=1,738)			0.002
Male	64.1	52.5	
Household income, % (n=1,718)			0.413
Low	17.6	14.2	
Medium low	30.9	28.2	
Medium high	25.9	29.4	
High	25.6	27.7	
Father's education level, % (n=1,137)			0.870
Elementary school graduate	6.4	7.8	
Middle school graduate	11.0	9.8	
High school graduate	39.8	41.8	
College graduate or higher	42.8	40.6	
Mother's education level, % (n=1,566)			0.714
Elementary school graduate	8.4	8.3	
Middle school graduate	8.6	6.5	
High school graduate	58.3	57.7	
College graduate or higher	24.7	27.5	
Father's night eating (n=1,261)			0.001
Yes	22.5	12.8	
Mother's night eating (n=1,618)			<0.001
Yes	20.3	8.9	
Consecutive breakfast skipping[2)] (n=1,718)			0.001
Yes	28.0	18.2	
Stress levels, % (n=1,719)			0.674
Very stressed	4.8	3.5	
Stressed	21.2	22.7	
Somewhat stressed	60.4	58.2	
Almost no stress	13.6	15.6	
Sleep hours, % (n=1,699)			0.943
<8 hours	57.2	58.3	
≥ 8 hours	42.8	41.7	
Physical activity level, % (n=1,719)			0.994
Inactive	30.2	30.2	
Inadequately active	35.2	35.6	
Active	34.5	34.2	
Attempted weight loss during the past year, % (n=1,738)			0.515
Yes	35.6	37.7	

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake.

1) p values obtained by Rao-Scott Chi square test or t-test.
2) Breakfast skipping was defined as not consuming breakfast during two days in a row (i.e.: the day of the interview, as well as the day before)

There was no significant difference between the two groups in terms of socioeconomic status or individual characteristics, such as stress, sleep hours, physical activity or previous attempts to lose weight.

2.2 Factors associated with night eating

Variables related to health-related characteristics among Korean adolescents were examined to determine which factors were associated with night eating after excluding cases with missing variables. The variables included in this regression analysis were described in Table 5.

Table 5. Variables included in the multiple logistic regression model to examine factors related to night eating among Korean adolescents (n=1,204)

Characteristics	Night eaters* (n=220)	Non-night eaters* (n=984)
Age (years), mean ± SE	15.1 ± 0.15	14.8 ± 0.08
Sex, %		
Male	64.7	50.9
Parental night eating, %		
Both parents	9.2	2.6
Father only	10.7	9.4
Mother only	9.5	6.2
Neither parent	70.6	81.9
Stress levels, %		
Very stressed	1.9	3.5
Stressed	18.7	22.5
Somewhat stressed	63.7	58.9
Almost no stress	15.7	15.1
Sleep hours, %		
<8 hours	57.7	58.2
≥ 8 hours	42.3	41.8
Physical activity level, %		
Inactive	31.2	30.6
Inadequately active	33.1	35.2
Active	35.7	34.2
Attempted weight loss during the past year, %		
Yes	30.1	38.2

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake.

The results of this regression analysis were shown in Table 6, and indicated that males had higher odds of night eating than females (OR: 1.85, 95% CI: 1.23 – 2.77).

Also, having both parents classified as night eaters increased the odds of being a night eater in a highly significant manner (OR: 4.37, 95% CI: 2.01 – 9.52), while subjects who had only one parent who was a night eater showed non-significantly higher odds of being night eaters. Other factors, such as stress levels, sleep hours, physical activity level and attempt at weight loss, did not seem to impact the odds for night eating.

Table 6. Factors related to night eating among Korean adolescents[1] (n=1,204)

Independent variables	Night eating† OR (95% CI)
Age	1.06 (0.96 –1.17)
Sex	
Male	1.85 (1.23 – 2.77)**
Female (reference)	
Parental night eating	
Both parents	4.37 (2.01 – 9.52)***
Father only	1.44 (0.84 – 2.47)
Mother only	1.80 (0.92 – 3.52)
Neither parent (reference)	
Stress levels, %	
Very stressed	0.52 (0.14 – 1.92)
Stressed	0.85 (0.42 – 1.68)
Somewhat stressed	1.06 (0.61 – 1.84)
Almost no stress (reference)	
Sleep hours, %	
<8 hours	0.98 (0.66 – 1.45)
≥ 8 hours (reference)	
Physical activity level, %	
Active	0.92 (0.56 – 1.50)
Inadequately active	0.90 (0.55 – 1.47)
Inactive (reference)	
Attempted weight loss during the past year, %	
Yes	0.83 (0.57 – 1.21)
No (reference)	

*p<0.05, **p<0.01, ***p<0.001

The data were analysed by complex samples analysis using multiple logistic regression model

† Night eating: Night energy intake ≥25% of Total Energy Intake

1) Reference category: non-night eater (Night energy intake < 25% Total Energy Intake)

3. Dietary intake and diet quality of night eaters and non-night eaters among Korean adolescents

Table 7 showed food group intake of night eaters and non-night eaters among Korean adolescents. There weren't significant differences between night eaters and non-night eaters in the number of servings consumed during the whole day from each food group, nor in the respective percentage of recommendation.

Table 7. Daily food group intake of night eaters and non-night eaters among Korean adolescents (n=1,738)

Food group	Number of servings			Proportion of recommendation[2)]	
	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]	Night eaters* (n=318)	Non-night eaters* (n=1,420)
	Mean ± SE			%	
Grains	4.3 ± 0.13	4.1 ± 0.05	0.065	115.8	119.9
Meat, eggs, fish, and beans	4.6 ± 0.29	4.1 ± 0.12	0.183	83.6	87.8
Vegetables	3.9 ± 0.25	4.2 ± 0.10	0.419	60.2	56.9
Fruits	1.1 ± 0.16	1.4 ± 0.08	0.596	70.5	65.9
Milk and dairy	1.2 ± 0.11	1.2 ± 0.05	0.767	61.7	60.0
Oils and sugars	3.0 ± 0.26	2.7 ± 0.11	0.241	56.1	60.9

The data were analysed by complex samples analysis; food groups from the Korean Nutrition Intake Standards *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by t-test
2) Proportion of recommendation = (consumed number of servings/recommended number of servings) × 100

Both groups showed 'Grain' intakes that exceeded the recommendation for sex and age of the Korean Food Guidance System, while for 'Vegetables', 'Fruits' and 'Milk and dairy' were around 30-40% below the recommended levels.

When examining dietary intake in terms of food groups during night-time (Table 8), night eaters had a highly significant greater number of servings for 5 food groups when compared to non-night eaters ($p<0.001$). The difference between night eaters and non-night eaters in terms of the food group 'Fruits', showed that night eaters consumed a significantly higher number of fruit servings during night hours, however, it had a lower level of significance than other food groups ($p=0.044$). Food intake of night eaters seemed to be mainly composed of the groups 'Meat, eggs, fish, and beans' and 'Grains'.

Table 8. Food group intake during night-time of night eaters and non-night eaters among Korean adolescents (n=1,738)

Food group	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]
	Mean ± SE		
Grains	1.5 ± 0.07	0.1 ± 0.01	<0.001
Meat, eggs, fish, and beans	2.0 ± 0.20	0.1 ± 0.01	<0.001
Vegetables	1.2 ± 0.11	0.1 ± 0.03	<0.001
Fruits	0.47 ± 0.16	0.32 ± 0.03	0.044
Milk and dairy	0.41 ± 0.06	0.17 ± 0.01	<0.001
Oils and sugars	1.39 ± 0.18	0.13 ± 0.02	<0.001

The data were analysed by complex samples analysis; food groups from the Korean Nutrition Intake Standards; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by t-test

Table 9 shows the distribution of subjects who consumed at least one serving from each food group in terms of the total number of foods groups consumed. Night eaters who consumed only one food group showed that for these subjects, only intake from grains amounted to one serving, indicating that caloric intakes from other groups were below the amount necessary to be considered a serving.

Table 9. Percentage of subjects who consumed at least one serving from each food group, by total number of food groups consumed, among Korean adolescents (n=1,738)

Total number of food groups consumed†	Night eaters*						Non-night eaters*					
	Grains	Meat, eggs, fish, and beans	Vegetables	Fruits	Milk and diary	Oils and sugars	Grains	Meat, eggs, fish, and beans	Vegetables	Fruits	Milk and diary	Oils and sugars
	%						%					
1	100.0	0.0	0.0	0.0	0.0	0.0	77.5	11.2	0.0	0.0	11.3	0.0
2	100.0	12.7	47.8	0.0	39.5	0.0	79.7	55.5	24.6	6.4	30.8	3.0
3	88.9	88.1	61.4	15.8	13.8	32.0	96.3	73.1	80.2	19.1	19.3	12.0
4	98.8	92.8	92.6	19.2	29.2	67.6	99.7	91.5	97.2	19.3	23.6	68.8
5	100.0	99.0	99.7	43.5	62.6	95.2	99.9	97.6	98.9	47.3	69.3	87.0
6	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency.
*Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake
†Number of food groups for which at least one serving was consumed, as defined by Korean Nutrition Intake Standards.

The mean nutrient intakes of night eaters and non-night eaters were showed in Table 10. Night eaters showed significantly higher fat intake (p=0.020) and higher percent of energy from fat when compared to non-night eaters (p=0.029). There were no significant differences for Total energy intake, micronutrients and other macronutrients.

Table 10. Daily nutrient intake of night eaters and non-night eaters among Korean adolescents

Nutrient intake	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]
	Mean ± SE		
Total energy, kcal	2,266.4 ± 72.7	2,165.8 ± 26.0	0.113
Carbohydrate, g	340.8 ± 8.8	334.9 ± 3.9	0.543
Protein, g	82.9 ± 3.0	78.6 ± 1.4	0.196
Fat, g	63.4 ± 2.6	56.8 ± 1.2	0.020
Fiber, g	5.87 ± 0.2	5.53 ± 0.1	0.225
Calcium, mg	519.0 ± 25.6	495.1 ± 10.0	0.377
Phosphorous, mg	1,224.1 ± 36.7	1,203.4 ± 17.2	0.607
Iron, mg	13.2 ± 0.6	12.9 ± 0.3	0.629
Sodium, mg	4,565.5 ± 221.0	4,191.7 ± 80.7	0.100
Potassium, mg	2,649.7 ± 108.9	266.2 ± 46.5	0.914
Vitamin A, μg RE	757.4 ± 81.2	749.2 ± 41.9	0.928
Thiamine, mg	1.59 ± 0.07	1.50 ± 0.02	0.201
Riboflavin, mg	1.44 ± 0.05	1.37 ± 0.02	0.210
Niacin, mg NE	17.4 ± 0.7	16.8 ± 0.2	0.444
Vitamin C, mg	87.9 ± 6.5	91.5 ± 3.1	0.613
Percent of energy from macronutrients			
Carbohydrate, %	61.3 ± 0.7	62.8 ± 0.3	0.055
Protein, %	14.4 ± 0.3	14.4 ± 0.1	0.950
Fat, %	24.3 ± 0.6	22.8 ± 0.3	0.029

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by ANCOVA, adjusted for age and sex,

When compared with non-night eaters, as it is showed in Table 11, night eaters presented lower energy intakes during the daytime, and also showed higher consumption of energy derived from snacks during the whole day diet as well as during night-time.

Table 11. Energy intake of night eaters and non-night eaters among Korean adolescents

Variable	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]
	Mean ± SE		
Total energy, kcal	2,266.4 ± 72.7	2,165.8 ± 26.0	0.113
Day energy intake, kcal	1,346.4 ± 40.4	2,049.2 ± 24.9	<0.001
Night energy intake, kcal	932.4 ± 31.2	227.60 ± 8.9	<0.001
Range of night energy intake, kcal (min~max)	203~3,334	0~937	-
Energy from meals, kcal	1,505.9 ± 46.9	1,665.11 ± 23.4	0.003
Energy from meals at night, kcal	805.6 ± 43.1	392.55 ± 21.6	<0.001
Energy from snacks, kcal	833.9 ± 42.3	543.1 ± 14.1	<0.001
Energy from snacks at night, kcal	636.6 ± 42.2	210.3 ± 8.8	<0.001

The data were analysed by complex samples analysis

*Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by ANCOVA

Measures of dietary quality are showed on Table 12. When comparing the overall diet quality, the Nutrient adequacy ratio (NAR) and Mean Adequacy Ratio (MAR) showed no significant difference between night eaters and non-night eaters except for NAR of vitamin C, which was lower among night eaters (p=0.016).

Also, Dietary Diversity Score (DDS) as lower among night eaters (p=0.008). The distribution of DDS of the subjects indicates that night eaters showed a higher percentage of subjects with very low DDS values and lower percentage of subjects with DDS values above 4.

Table 12. Dietary quality of night eaters and non-night eaters among Korean adolescents (n=1,738)

	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]
Nutrient adequacy ratio (NAR)	Mean ± SE		
Protein	0.94 ± 0.008	0.95 ± 0.004	0.536
Calcium	0.54 ± 0.018	0.52 ± 0.008	0.376
Phosphorus	0.90 ± 0.010	0.92 ± 0.005	0.581
Iron	0.72 ± 0.018	0.72 ± 0.008	0.998
Vitamin A	0.69 ± 0.019	0.70 ± 0.009	0.602
Thiamine	0.90 ± 0.012	0.89 ± 0.005	0.295
Riboflavin	0.81 ± 0.015	0.79 ± 0.007	0.332
Niacin	0.84 ± 0.015	0.84 ± 0.007	0.649
Vitamin C	0.57 ± 0.021	0.63 ± 0.011	0.016
Mean Adequacy Ratio (MAR)	0.77 ± 0.011	0.77 ± 0.005	0.724
Dietary Diversity Score (DDS)[2)]	%[3)]		
0-2	5.0	1.4	0.004
3	24.5	20.9	
4	44.1	46.4	
5	26.4	31.3	
	Mean ± SE		
Mean DDS	3.9 ± 0.05	4.0± 0.02	0.008

The data were analysed by complex samples analysis; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by t-test or Rao-Scott chi-square
2) DDS is expressed in a scale of 0-5.
3) Percentage of subjects was calculated from weighted frequency

4. Night eating and body weight among Korean adolescents

Descriptive statistics for body weight measures are shown on Table 13. Subjects presented BMI z-scores significantly different between night eaters and non-night eaters (p=0.016), with night eaters showing values that despite being higher, were within healthy weight range. However, BMI groups did not show any difference between night eaters and non-night eaters.

Table 13. Distribution of body weight of night eaters and non-night eaters among Korean adolescents

Variables	Total (n=1738)	Night eaters* (n=318)	Non-night eaters* (n=1,420)	p[1)]
		Mean ± SE		
BMI z-score	-0.01 ± 0.02	0.11 ± 0.05	-0.04 ± 0.03	0.016
BMI group		n[2)] (%)[3)]		
Underweight	108 (6.3)	17 (4.2)	91 (6.8)	
Healthy weight	1314 (75.4)	245 (77.1)	1069 (75.0)	0.471
Overweight	194 (11.0)	41 (10.6)	153 (11.1)	
Obese	122 (7.3)	26 (8.1)	96 (7.1)	

The data were analysed by complex samples analysis; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) p values obtained by t-test and Rao-Scott Chi-square test.

4.1 Night eating BMI z-score

The association of night eating with BMI z-score was assessed in a linear regression model. The variables used for this model are described in Table 14. The analysis showed in Table 15, indicates a significant association between night eating and BMI z-score (β=0.18, p=0.007). However, this association appeared to be significant only among female subjects after stratifying by sex (β=0.28, p=0.004).

Table 14. Variables included in multiple linear regression model to examine the relation of night eating to BMI z-scores among Korean adolescents (n=1,698)

Variables	Night eaters* (n=1,373)	Non-night eaters* (n=325)
Sex, %		
Male	63.8	52.6
Physical activity, %		
Sedentary lifestyle[1)]	30.1	30.4
Stress levels, %		
High stressed levels	5.0	3.3
Sleep hours, %		
<8 hours	56.8	58.8
Age (years), mean ± SE	15.26 ± 0.12	14.97 ± 0.65
Total energy intake, kcal	2,302 ± 60.5	2,162 ± 27.0

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

1) Sedentary lifestyle = Inactive

Table 15. Relation of night eating to BMI z-score among Korean adolescents[1] (n=1,698)

Independent variables		β	p
All subjects	Night eating	0.18	0.007
	Sedentary lifestyle	-0.26	<0.001
	High stress levels	0.24	0.165
	<8h of average sleep per night	0.19	0.004
	Male sex	-0.08	0.197
	Age	-0.006	0.664
	Total energy intake	-7×10^{-5}	0.018
Model statistics		R^2=0.032, Wald F=5.108 (p<0.001)	
Males only	Night eating	0.11	0.191
	Sedentary lifestyle	-0.28	0.003
	High stress levels	0.39	0.081
	<8h of average sleep per night	0.20	0.008
	Age	-0.02	0.157
	Total energy intake	-3.4×10^{-5}	0.247
Model statistics		R^2=0.031, Wald F=3.214 (p=0.004)	
Females only	Night eating	0.28	0.004
	Sedentary lifestyle	-0.25	0.004
	High stress levels	0.12	0.612
	<8h of average sleep per night	0.15	0.084
	Age	0.01	0.603
	Total energy intake	5.3× 10-5	0.052
Model statistics		R^2=0.040, Wald F=4.52 (p<0.001)	

The data were analysed by complex samples analysis using multiple linear regression analyses

*Night eating: Night energy intake ≥25% of Total Energy Intake

1) Regression models were performed for the whole sample and stratified according to sex to test for effect modification.

4.2 Night eating and BMI-groups

A multinomial logistic regression explored the relationship between night eating and BMI groups, adjusting for age, sex and total energy intake. The characteristics of the variables included here were described by BMI-group in Table 16. This model did not find a significant relationship between overweight/obesity and night eating (Table 17).

Table 16. Variables included in multinominal logistic regression model to examine the relation of night eating to BMI groups among Korean adolescents (n=1,738)

	BMI groups			
Variables	Underweight	Healthy weight	Overweight	Obese
Age (years), mean ± SE	15.9 ± 0.2	15.0.± 0.06	14.8 ± 0.1	15.2 ± 0.1
Sex, %				
Male	56.7	54.7	57.4	51.0
Total energy intake (kcals), mean ± SE	2,349 ± 83	2,189 ± 28	2,289 ± 81	1991 ± 91
Night eating status*				
Night eaters	86.2	78.8	80.0	76.9
Non-night eaters	13.8	21.2	20.0	23.1

The data were analysed by complex samples analysis; percentage of subjects was calculated from weighted frequency; *Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

Table 17. Relation of night eating to BMI groups in Korean adolescents (n=1,738)

Independent variables	BMI groups[1)]		
	Underweight	Overweight	Obese
	OR (95% CI)		
Age	1.201 (1.058 – 1.365)**	0.948 (0.872 – 1.031)	1.048 (0.948 – 1.159)
Sex			
Male	1.043 (0.640 – 1.702)	1.083 (0.738 – 1.589)	1.006 (0.619 – 1.634)
Female (reference)			
Total energy intake	1.000 (1.000 – 1.000)	1.000 (1.000 – 1.001)	1.001 (0.999 – 1.001)
Night eating status[2)]			
Night eaters	0.533 (0.280 – 1.012)	0.896 (0.535– 1.403)	1.130 (0.647 – 1.975)
Non-night eaters (reference)			

*p<0.05, **p<0.01, ***p<0.001

The data were analysed by complex samples analysis using multinomial logistic regression model. Model statistics: Nagelkerke R^2=0.023 Wald F= 1.704 (p = 0.061)

1) Reference category: healthy weight

2) Night eaters: Night energy intake ≥25% of Total Energy Intake; non-night eaters: Night energy intake <25% of Total Energy Intake

V. DISCUSSION

The results of the present study indicated that around 21% of Korean adolescents were classified as night eaters, defined as subjects who consumed 25% or more of their daily Total Energy Intake at night. Also, around 60% of adolescents ate something at night. These results were in concurrence with a recent survey performed in Gyeonggi province, the most populous province in Korea, indicating that 60% of middle school students ate at night more than once a week (Cho et al. 2014). Other studies in Korea indicated that night eating tendency and night snacking were more frequent in younger adults (Jung et al. 2006).

The analysis showed significant differences between night eaters and non-night eaters in terms of sex and parental night eating. According to our results, males presented an 85% higher odds of night eating, representing 64% of adolescent night eaters. Previous research showed inconsistent results when exploring sex distribution in night eating. Some studies with Koreans and international

populations have suggested a positive association between males and night eating syndrome or nocturnal snacking (Colles, Dixon, and O'Brien 2007, Jung et al. 2006, Suh, Lee, and Chung 2012). In contrast, other studies have not showed differences in distribution of night eating between sexes (Cho et al. 2014, Ochiai et al. 2013, O'Reardon, Peshek, and Allison 2005).

In this study, night eating was associated with parental night eating habits of both parents. These results were in agreement with a study involving German 6-year-old children, in which the risk of suffering from night eating increased seven times in children with mothers who reported night eating themselves (Lamerz et al. 2005). There is evidence indicating that food preferences and selection are strongly influenced by parental choices, and that this could not only determine their children's weight status but also the efficacy of weight control interventions (Collins et al. 2011, Klesges et al. 1991, Wardle et al. 2001).

In this study, night eaters had a lower energy intake

during daytime as well as higher prevalence of consecutive breakfast skipping. These characteristics indicate delayed eating behaviour. Morning anorexia, in the form of breakfast skipping, is one of the key features of Night Eating Syndrome (NES) (Allison et al. 2010, Gluck, Geliebter, and Satov 2001). Although the present research did not focus on NES, it has been proposed that subsyndromal cases that don't possess all the diagnostic criteria for NES should be taken into account due to possible long term metabolic consequences that could arise (Almoosawi et al. 2013a, b, Almoosawi et al. 2013, de Zwaan et al. 2006).

It has been suggested that the timing of food consumption has been changing over time and moving to later hours of the day in recent years (Almoosawi et al. 2011). With the advent of modern life, human's schedules and habits have been changing gradually. Variations in daily rhythms due to the use of artificial lighting (LeGates, Fernandez, and Hattar 2014) have allowed activity and food

intake to occur during night hours and this may have a detrimental effect on human metabolic health (Garaulet, Ordovas, and Madrid 2010, Wyse, Biello, and Gill 2014). Previous reports have stated that delayed eating behaviours were accompanied by a delayed physical activity pattern (Gallant et al. 2013), indicating a possible overall alteration of the circadian biological clock. Although night eaters appeared to have delayed eating behaviour, sleep hours and physical activity didn't show significant differences between night eaters and non-night eaters in this study.

According to our results, night eating appeared to be associated with higher intake of both full meals and snacks during the whole day as well as during night-time. This pattern indicates a possible point of intervention for night eating. Night snacking has been associated with psychological distress (Colles, Dixon, and O'Brien 2007) and could be related to eating disorder symptoms (Striegel-Moore et al. 2010). Therefore approaches

targeting nocturnal snacking and possibly related psychological disturbances may help resolve the root causes of night eating.

In this study, night eating was also associated with lower Dietary Diversity Scores (DDS) among night eaters, when compared to non-night eaters. These results were in accord with consistent findings in the literature indicating that evening chronotypes had a tendency to consume less healthy diets; this tendency has been explained by an inclination of individuals with delayed eating patterns to select high carbohydrate and palatable foods during late eating occasions (Gallant, Lundgren, and Drapeau 2014). In contrast, the results of the present study indicated that Korean adolescent night eaters did not consume more energy from carbohydrates, but instead they had a higher proportion of energy intake from fat. In our results, there was no difference in terms of food group intake between night eaters and non-night eaters. This indicates that despite differences in terms of energy intake, both groups

may have similar diets.

The present study showed a relationship between night eating and BMI z-scores. A higher energy intake during night-time has previously been associated with a higher BMI z-scores and higher risk of being overweight or obese (Baron et al. 2011, Huang 2014, Wang et al. 2014). Also a behavioural control of evening and night-time habits might support weight loss or prevent weight gain beyond usual dieting strategies (Allison, Goel, and Ahima 2014, Gluck, Geliebter, and Satov 2001).

The results of the present study indicated that mean energy intake from fat was higher among night eaters. Previous studies have suggested that fat intake at night is related to higher BMI, body fat percentage and waist circumference (Dattilo et al. 2010), while other studies blame a higher carbohydrate intake for this relationship (Gallant, Lundgren, and Drapeau 2014). It is not clear which mechanisms could mediate the relationship between night eating and weight. Night-time snacking has been found to

change metabolism in an acute manner, as it increases the risk of obesity by elevating total LDL cholesterol and reducing whole body fat oxidation, without affecting daily energy expenditure (Hibi et al. 2013).

It has been argued that reduced sleep time and sleep disorders may have a role in the night-time food intake by making people susceptible to greater caloric intake (Spaeth, Dinges, and Goel 2013). Lack of sleep among Korean adolescents could play a role in night eating tendency. Around three quarters of Korean adolescents from a nationally representative sample reported that they did not get enough sleep (Korea Centers for Disease Control & Prevention [KCDC] 2008), and lack of sleep has been strongly associated with a greater risk of being overweight and obese in this age group (Park 2010). Nevertheless, this relationship seemed to be mediated by disordered eating rather than sleep disorders, since sleep deficits are not related to weight gain or obesity, but instead to the act of nocturnal eating (Yeh and Brown 2014). Also, calorie intake

after 8:00 PM has been associated with an increased risk of obesity, independently of sleep timing and duration (Baron et al. 2011).

Some studies indicate that the disturbance of circadian rhythms may produce metabolic alterations that, when combined with behavioural changes could promote obesity, such as eating at night as a consequence of exposure to artificial lighting for example (Arble et al. 2009, Wyse, Biello, and Gill 2014).

In the present study, the relationship between night eating and BMI z-score remained significant only for females after stratification for sex. A study in middle-aged subjects suggested that only women who were already obese had higher weight gain six years after an initial assessment of night eating (Andersen et al. 2004). Female adolescents have shown a tendency to develop a delayed chronotype earlier than young males (Roenneberg et al. 2004). This difference may be attributable to distinct endocrine factors between sexes.

In this study, night eating did not appear to increase the risk for being overweight or obese, despite its association with BMI z-score. It appears that the differences in BMI z-scores between night eaters and non-night eaters are only within the range of healthy weight. This disparity could be explained by the age of the sample examined in this study. Age seems to moderate the relationship between night eating and BMI. In other words, weight gain may only occur after longer periods of engaging in the behaviour of night eating, thus causing small or no relationship to be found in younger samples (Meule et al. 2014).

As the results of this study and the related evidence of the studies presented above suggest that timing of food intake, and in specific night eating should be linked to sex and parental night eating, and appears to be associated to lower dietary quality. The role of night eating on body weight status is questionable due to BMI z-score differences being within the healthy weight range and the lack of association with BMI groups.

VI. CONCLUSIONS

1. Summary and conclusions

This study examined dietary and health characteristics and factors associated with night eating among Korean adolescents. The main results of the study are the following:

1) Around 21% of Korean adolescents consumed 25% or more of their energy intake during night hours, and therefore were classified as night eaters.

2) Being male and parental night eating of both parents appeared to be factors that significantly increased the odds of night eating.

3) Night eating in Korean adolescents was accompanied by delayed eating behaviour, increased breakfast skipping, and lower dietary quality, as evidenced by higher consumption of energy from snacks, higher energy intake from fat and lower dietary diversity.

4) Night eating was associated with higher BMI z-scores in Korean adolescents. After stratifying by

sex, only female adolescents showed a significant positive relationship between night eating and BMI z-scores. Nevertheless, this association was within the healthy weight range and night eating did not appear to increase the risk of being overweight or obese, and therefore may not indicate increased weight status.

2. Conclusion and suggestions

The findings of the present study indicate that male adolescents and also those whose parents were classified as night eaters showed higher tendency to be also classified as night eaters. Also, night eating among Korean adolescents was related to delayed eating behaviours, as exemplified by breakfast skipping and lower daytime energy intake, and lower diet quality in general.

Because data were obtained from KNHANES, a cross-sectional study, the associations found here do not necessarily imply the existence of a causal relationship.

This study might be confounded by lack of data on important variables, such as psychological factors related to night eating or comorbidity with other eating disorders. Also the fact that dietary data were derived from a one day 24 hour dietary recall, limits the ability to measure usual intake and determine if night eating is a habitual behaviour.

Our results seem to indicate the importance of incorporating the temporal dimension to diet planning and nutrition programs, especially those targeted at adolescents; and also the relevance of the inclusion of parents to their children's lifestyle changes. Nutrition education focused on preventing night eating can be integrated as part of general nutrition and weight control programs. An example of this was a technology-based 8-week weight loss intervention performed among university students in the eastern United States which as part of its text messaging education intervention, sent tips based on self-identified risk behaviours, one of these behaviours being late-night snacking (Napolitano et al. 2013).

Nevertheless, since night eating can be a manifestation of deep rooted psychological complications, as in the case of NES, the integration of NES screenings could serve to recognize and treat cases that otherwise would not be identified as psychological disorders. The influence of parental night eating behaviour implies that in order to ensure that any strategy targeted to decreasing night energy intake to work, it is essential to integrate parents into diet interventions. This means that a family centred approach might work better in adolescents, due to the tendency to mimicking parental habits.

The findings presented in this study can be used as a foundation for future research about the topic of night eating. To the knowledge of the author, this is the first study to evaluate the relationship between weight and night eating among Korean adolescents and one of the few at an international level.

This research area seems to be constantly growing all over the world and in recent years in South Korea, as

indicated by the publication of studies that explore night eating and nocturnal snacking, especially those focused on university students (Cho et al. 2014, Jun, Choi, and Yun-Jung 2015, Joung and Koo 2014, Jung et al. 2006, Suh, Lee, and Chung 2012).

Some important questions that may need addressing are related to the need of standard definitions of night eating and NES. Also, it is important to ascertain what is the role of metabolic alterations caused by naturally delayed chronotypes and by non-natural changes in diurnal periodicity, such as those caused by shift work, late-night studying, nocturnal technology usage (internet use, mobile phones) or insomnia. In this sense, researchers should determine if possible changes in body weight related to night eating would be a consequence of metabolic changes or if they are product of behavioural alterations that lowered dietary quality as a consequence of bad decision making processes.

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국문초록

한국 청소년의 야식 섭취에 따른 식생활 및 건강 관련 특성

다수의 연구들이 야식 섭취와 같이 늦어지는 식행동은 낮은 질의 식사, 건강 위험 행동, 비만 위험 증가와 관련될 수 있다고 보고하였다. 본 연구는 야식은 섭취하는 한국 청소년의 식생활 및 건강 관련 특성을 조사하는데 목적이 있다. 2010-2012 국민건강영양조사 자료의 12-18세 한국 청소년 1,738명을 대상으로 24시간 회상자료와 인구통계학적 조사자료를 분석하였다. '야식 섭취'는 21시에서 6시 사이에 총 1일 에너지 섭취량의 25% 이상을 섭취하는 것으로 정의하였고, 야식을 섭취하는 대상자를 '야식군', 그 외의 대상자를 '비야식군'으로 분류하였다. 그 결과, 한국 청소년의 약 21%가 야식군인 것으로 나타났다. Rao-Scott χ^2 검정과 t-검정을 사용하여 분석한 결과, 청소년 야식군은 비야식군에 비해 아침결식의 증가 ($p=0.001$), 낮은 식품군점수로 나타난 식사의 질 저하 ($p=0.008$), 간식으로부터의 높은 에너지섭취 ($p<0.001$), 지방으로부터의 높은 에너지섭취 비율 ($p=0.029$)을 보였다. 1일 식품군 섭취에 있어서는 야식군과

비야식군 간에 유의한 차이가 보이지 않았다. 로지스틱회귀분석 결과, 부모가 모두 야식군인 청소년의 경우 그렇지 않은 청소년에 비해 야식군일 가능성이 4.37배인 것으로 나타났으며, 남자청소년의 야식 섭취 확률이 여자청소년보다 85% 높은 것으로 나타났다. 다중선형회귀분석 결과, 여자청소년의 경우에서만 야식 섭취와 BMI z-score (β=0.28, p=0.004) 사이에 유의한 관계가 나타났다. 그러나, 다항로지스틱 회귀분석에 의하면, 야식 섭취가 과체중이나 비만이 될 확률을 증가시키지는 않았다. 그러므로 여자청소년에게서 나타난 야식 섭취와 BMI z-score의 관계는 건강 체중 범위에서만 존재하는 것으로 나타났다. 결론적으로, 남자청소년과 부모가 야식군인 청소년이 야식군이 될 경향이 높은 것으로 나타났다. 또한, 한국 청소년의 야식 섭취는 아침 결식과 낮 시간의 적은 에너지 섭취와 같은 늦어지는 식행동 및 낮은 식사의 질과 관련되어 있었다. 본 연구의 결과는 청소년은 대상으로 한 영양 교육 프로그램에 있어 야식 섭취에 대한 고려가 있어야 함을 시사한다.

주요어: 야식, 청소년 야식군, 시간영양학, KNHANES.

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